Team develops 3-D sensor array for detection of neural responses

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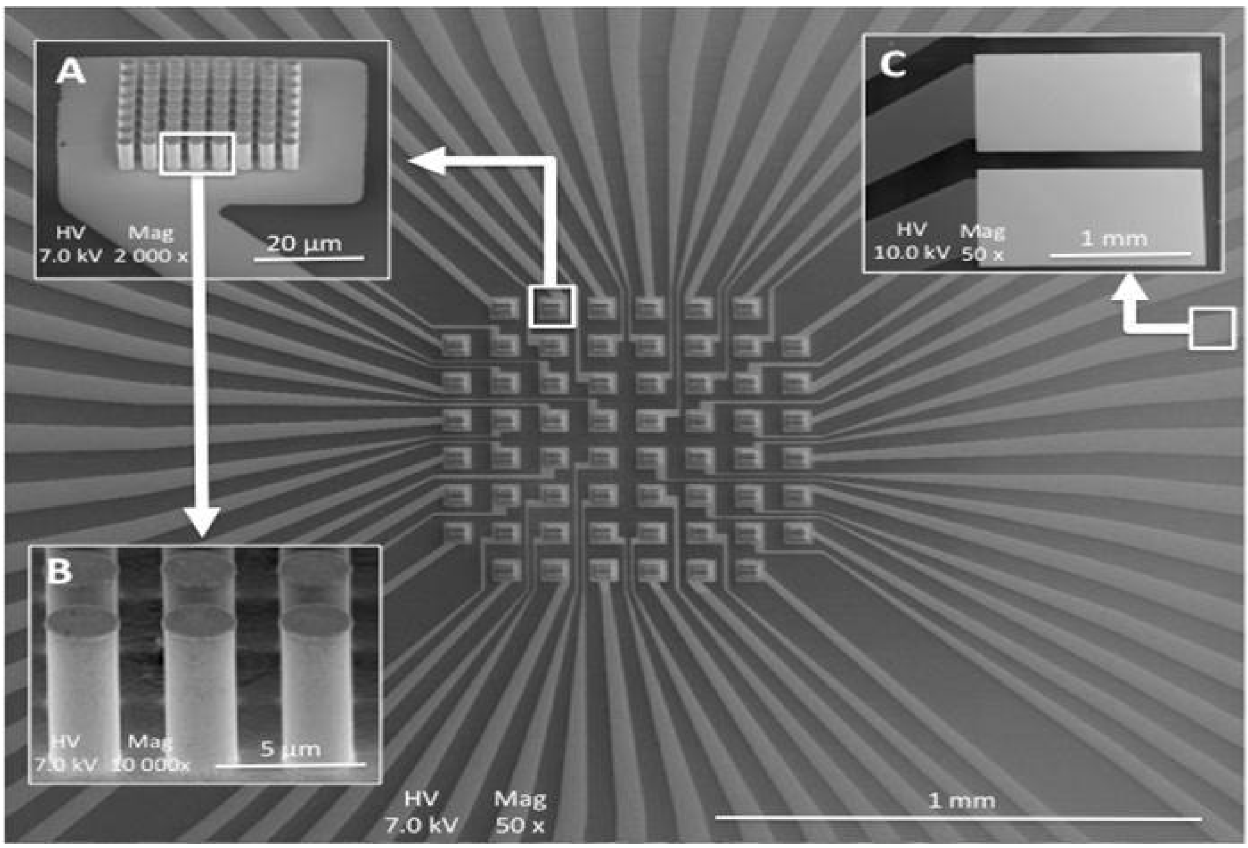

Neural degenerative diseases and traumatic injuries affect millions of people worldwide, motivating the development of neural prosthetic interfaces to restore sensory or motor function in affected individuals. Advances in neural sensing and stimulation interface technology would allow a more comprehensive understanding of neural function while leading to the development of hybrid biological-electronic sensor devices for robust, functioning neural prosthetic systems. Los Alamos researchers and collaborators have demonstrated a prototype neural interface device of a novel 3-D device architecture. *Electrochemical Society (ECS) Journal of Solid State Science and Technology* published the research.

Significance of the research

Current techniques of neural activity sensing and stimulation employ multi-electrode arrays that typically incorporate metal electrodes and measure or apply currents via an electrochemical junction, leading to corrosion and charge transfer across the electrode-tissue interface. High-density neural interface technology will require active circuitry within the implant, and the device must withstand corrosion and induce minimal damage at the electrode/tissue interface.

This achievement advances neural sensing technology toward long-term implantable neural interfaces. Systems such as this have applications for advanced prosthetic systems. Examples include bidirectional control and feedback interfaces for prosthetic limbs. High density neural interfaces also provide powerful new tools for understanding the mechanisms of information encoding and processing by neural systems, which could allow researchers to emulate the function of biological brains for autonomous navigation, control and sensor processing by engineered systems such as robots or micro-UAVs (unmanned aerial vehicles). Government agencies seek these systems for potential applications ranging from general surveillance, to treaty verification, to maintaining custody of weapons systems and components.

Research achievements

The researchers developed a three-dimensional micro pillar sensor array that incorporates more than 3,600 capacitive probes organized into 60 independent sensor sites (for compatibility with existing electronics) spread over an area of 750 microns^2. Each sensor site consists of an 8x8 array of platinum micropillars to maximize the capacitive response, interconnected by leads on the device. Atomic layer deposition of hafnium oxide fully insulates the device. The team utilized capacitive coupling of the 3-D device to sense electrical activity in excised retinal tissue.

The team plans to produce much higher resolution sensor and stimulation arrays through incorporation of active electronics to address individual microprobes individually, and the development of hybrid neural electronic interfaces by incorporating cells within the sensor arrays, which are the natural target for connections from the central nervous system.

The research team

Researchers include Brittany Branch of University of New Mexico and Materials Synthesis and Integrated Devices (MPA-11), Jennifer L. Schei and John S. George of Applied Modern Physics (P-21), Gautam Gupta and Andrew Dattelbaum of MPA-11, and Kateryna Artyushkova and Dimiter N. Petsev of UNM. The Laboratory Directed Research and Development (LDRD) program funded the Los Alamos portion of the research, which supports LANL’s Global Security mission area and the Science of Signatures and Information, Science, and Technology science pillars. This work is an outgrowth of the DOE Artificial Retina project and was performed, in part, at the Los Alamos Center for Integrated Nanotechnologies (CINT), a DOE Basic Energy Sciences funded user facility, and Physics Division.